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ABSTRACT

Sixty-four learning disabled sixth, seventh, and eighth grade students were assigned to 24 small instructional groups which were in turn assigned at random to mnemonic and control conditions. Instructional groups were then given three daily lessons on dinosaurs in counterbalanced order. The lessons involved dinosaur vocabulary, attributes of dinosaurs, and reasons for dinosaur extinction. Mnemonic groups were taught the information using keyword and pegword techniques. Control instructional groups were taught the same information using the principles of direct instruction, including teacher-directed questioning, choral group responding, fast instructional pacing, and cumulative review. A test was given after each lesson on that lesson's content. On the fourth day, all students were given production and identification tests on the content of all three lessons. Results indicated that mnemonic groups outperformed control groups on both delayed tests as well as the attributes and extinction lesson. Mnemonic groups also outperformed control groups on the vocabulary lesson and on a test of applicaton of dinosaur word parts. In addition, it was found that control subjects' responses revealed significantly more intralist intrusions than mnemonic subjects'. No meaningful trend across days of instruction was observed for either condition, and interference across lessons (interlist intrusions) were not observed in either condition. Results suggested that (1) previously validated mnemonic techniques were successful over several days of instruction; (2) mnemonic instructional groups performed significantly better than a direct questioning condition on a delayed test of extended instruction; (3) mnemonic and control Ss were equally able to apply learned vocabulary information; and (4) mnemonic instruction appeared to exhibit no inhibiting effect over several different lessons and days of instruction. (Author/CL)

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Extended Mnemonic Instruction with Learning Disabled Students

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Abstract

Sixty-four learning disabled sixth, seventh, and eighth grade students were assigned to 24 small instructional groups which were in turn assigned at random to mnemonic and control conditions. Instructional groups were then given three daily lessons on dinosaurs in counterbalanced order. The lessons involved (a) dinosaur vocabulary, (b) attributes of dinosaurs, and (c) reasons for dinosaur extinction. Mnemonic groups were taught the information using keyword and pegword techniques. Control instructional groups were taught the same information using the principles of direct instruction, including teacher-directed questioning, choral group responding, fast instructional pacing, and cumulative review. A test was given after each lesson on that lesson's content. On the fourth day, all students were given production and identification tests on the content of all three lessons. Results indicated that mnemonic groups outperformed control groups on both delayed tests as well as the attributes and extinction lesson. Mnemonic groups also outperformed control groups on the vocabulary lesson, loose scoring, and on a test of application of dinosaur word parts. In addition, it was found that control subjects' responses revealed significantly more intralist intrusions than mnemonic subjects'. Finally, it was seen that no meaningful trend across days of instruction was observed for either condition, and interference across lessons

(interlist intrusions) were not observed in either condition. These results suggested that (a) previously validated mnemonic techniques were successful over several days of instruction, (b) mnemonic instructional groups performed significantly better than a direct questioning condition on a delayed test of extended instruction, (c) mnemonic and control subjects were equally able to apply learned vocabulary information, and (d) mnemonic instruction appeared to exhibit no inhibiting effect over several different lessons and days of instruction. Implications for special education are given.

Extended Mnemonic Instruction with Learning Disabled Students

Recent research has suggested that the learning and retention of associative factual information of students classified as learning disabled (LD) can be greatly enhanced by the use of transformational mnemonic strategies (see Mastropieri, Scruggs, & Levin, 1985, for a review). Such strategies incorporate what Levin (1983) has referred to as the "three R's" of mnemonic instruction: stimulus Recoding, semantic Relating, and systematic Retrieving. By these means, unfamiliar stimuli are recoded to familiar, acoustically similar "keywords" (Atkinson, 1975), related via interacting pictures on images to referent terms, to provide a direct process for retrieval. Several different applications of mnemonic techniques have been experimentally validated with LD students.

Mastropieri, Scruggs, Levin, Gaffney, and McLoone (1985) taught LD students unfamiliar native language vocabulary using the keyword method or a teacher-led cumulative rehearsal ("direct instruction") condition. For example, to learn that the English vocabulary word bugsha means money, mnemonic condition students were given a keyword for bugsha (bug) and shown an interactive picture of a bug sitting on a pile of money. Students were then instructed, when asked the meaning of bugsha, to think of the keyword bug, to retrieve the picture of the bug sitting on a pile

of money, and respond with the correct definition, money. Students given such mnemonic strategies recalled over twice as many vocabulary words as students taught by "direct instruction."

In an extension of the keyword strategy, Mastropieri, Scruggs, McLoone, and Levin (in press) taught LD students multiple classifications of North American minerals using mnemonic or teacher-directed rehearsal techniques. To remember, for example, that corundum is a hard mineral, dark in color, and used in the home, mnemonic condition students were first given a keyword for corundum, car. They were then shown a picture of dark colored toy cars being polished by an old man (for hard mineral) in a home (living room) setting. Control subjects were given teacher-led drill and practice on mineral names and classifications, or undirected "free study," for an equivalent amount of time. Mnemonically instructed students learned nearly 50% more mineral classifications than control students.

In a third adaptation of mnemonic instruction, Mastropieri, Scruggs, and Levin (1984) taught LD students hardness levels of North American minerals using rhyming pegwords (one is bun, two is shoe, etc.) coupled with keywords for mineral names. For example, to teach that topaz is number 8 on the hardness scale, mnemonic condition students were given a keyword for topaz (top) and shown a picture of a top spinning on a gate (pegword for eight). Again, mnemonically instructed subjects learned over twice as much information as students in control conditions.

Research related to the above investigations has supported the effectiveness of mnemonic instruction with LD students in learning of multiple science facts (Scruggs, Mastropieri, Levin, & Gaffney, in press) and memory for expository prose (Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1985). Additionally, some initial evidence has been provided that LD students can be trained to transfer effectively the keyword strategy to their own independent learning (McLoone, 1985). In spite of the promise afforded by these initial successes of mnemonic instruction with students notable for failures in associative learning tasks (Torgesen, 1980), however, many questions remain to be explored. One strong limitation of all mnemonic studies to date involving LD students is the fact that instruction has been limited to a single list of facts or fact systems taught within a single instructional session. With the exception of a single investigation (Mastropieri, Scruggs, & Levin, in press), students have been taught individually rather than in small groups, which is more characteristic of instruction provided in learning disabilities classes and resource rooms. Finally, the adaptability of mnemonic instruction to several aspects of a single content area has yet to be assessed with a learning disabled population. It was to these ends that the present investigation was addressed.

A question of central importance to the research described here is whether the initial effectiveness of mnemonic instruction

would diminish as different mnemonic systems are presented over several days of instruction. That is, would LD students, already known for exhibiting difficulty in forming strong stimulus-response connections, become confused when confronted with multiple sets of mnemonic pictures describing related content? To investigate this issue, three separate lessons describing facts about dinosaurs were developed. These lessons were non-overlapping to ensure that knowledge of one lesson would not facilitate knowledge of another lesson. Since the lessons were independent, order of presentation could be counterbalanced so that potential inhibiting or facilitating effects over three days of instruction could be assessed without concern for possible contaminating effects of relative lesson difficulty.

The three separate lessons each involved mnemonic adaptations demonstrated to be effective in previous investigations. One lesson provided definitions of dinosaur word parts (e.g., bronto, meaning thunder; saur, meaning lizard). These word parts were taught separately, as in the Mastropieri, Scruggs, Levin, Gaffney, and McLoone (1985) investigation. In a second test, the students' ability to apply the learned information was assessed by providing the entire dinosaur name (e.g., what does bronto/saur mean?). In a second lesson, students were taught multiple attributes of individual dinosaurs, similar to the procedures of Mastropieri, Scruggs, McLoone, & Levin (in press). In a third lesson, possible

reasons for dinosaur extinction were taught in order of plausibility, using a pegword strategy similar to that used by Mastropieri, Scruggs, & Levin (1984) for recalling numbered information. On the fourth day, cumulative recall of all information was assessed.

The instructional procedure used for comparison was adapted from teaching techniques used in "direct instruction" materials for promoting associative learning (e.g., Engelmann, Haddox, Hanner, & Osborne, 1978), and highly recommended for use in special education (Becker, Engelmann, Carnine, & Maggs, 1982; Gersten, 1985). Teacher-led rehearsal strategies recommended by Engelmann et al. (1978) were employed for the vocabulary and extinction lessons, while a "visual-spatial" display, recommended for the teaching of "fact systems" (Engelmann & Carnine, 1982) was employed for the dinosaur attributes lesson. This instructional condition (here described as "direct questioning") was chosen to control for experimenter interaction in the mnemonic condition as well as to provide the "best available treatment" for an effective control condition (Borkowski & Buechel, 1983, p. 105).

Method

Subjects

Sixty-four students from rural western communities participated in this investigation. All students had been classified as "learning disabled" according to federal, state, and

school district guidelines which included a 40% discrepancy between ability and achievement in one or more areas of academic functioning. Twenty-three 6th, 22 seventh, and 19 eighth graders were included in the sample. The 19 girls and 45 boys had a mean IQ (Wechsler Intelligence Scale for Children-Revised) of 92.5 (SD = 12.1). Mean reading grade equivalent as assessed by the Comprehensive Test of Basic Skills was 3.8 (SD = 1.3).

Materials

Vocabulary Lesson (Lesson One)

Sixteen parts of dinosaur names were identified for this study (e.g., Calbert). Two word parts served as examples. The remaining 14 parts, when combined, formed 12 different dinosaur names. The 14 word parts and 12 dinosaur names served as test items. All test items were the same for both treatments. Sixteen 8-1/2 in. x 11 in. (21-1/4 cm x 27-1/2 cm) picture cards of word parts were developed for each condition described below. Presenters' scripts were prepared for both conditions.

Mnemonic condition. For each mnemonic card, the word part was written with the associated keyword in brackets along with the meaning. The picture represented the interaction between the keyword and the meaning. For example, for the work part ornith, meaning bird, the word part ornith was written with the keyword (oar) in brackets on the left side, the meaning bird printed on the right side, and the picture of a bird carrying an oar was

drawn on the word card (see Figure 1). In addition, a presenter's script was prepared.

Insert Figure 1 about here

Direct questioning condition. Materials for the direct questioning condition were the same as those for the mnemonic condition with the exception that the keyword and pictorial reference to the keyword were deleted (see Figure 2).

Insert Figure 2 about here

Attribute Lesson (Lesson Two)

Eleven dinosaurs, each with three associated attributes, were used for this study, none of which were used in the vocabulary lesson (Calbert, 1983). Three dinosaurs were used as examples, and the remaining eight dinosaurs were used as target items. Each dinosaur was described as being from the "early," "middle," or "late" period (for Triassic, Jurassic, or Cretaceous periods of the Mesozoic era), as being a "meat eater" (carnivore) or "plant eater" (herbivore), and as having a specific attribute specific to each dinosaur (e.g., "had feathers"). Presented scripts accompanied each lesson. The specific materials for each condition are described below.

Mnemonic condition. Picture cards, 8-1/2 x 11 in. (21-1/4 x 27-1/2 cm) in size, were prepared for each of the dinosaurs. Each card consisted of: (a) dinosaur name, (b) keyword, (c) word "early," "middle," or "late" to indicate the period in which the dinosaur lived, (d) the phrase "green plants" or "red meat" to indicate diet habits, (e) a phrase to indicate the specific attribute (e.g., "had feathers"), and (f) an interactive picture of the keyword and three attributes. In each picture, the "period" attribute was represented by either (a) a morning scene with a rooster ("early"); (b) a hot, mid-day scene ("middle"); or (c) a night scene with an owl ("late"). To represent whether the dinosaur was a carnivore or herbivore, the keyword representation was colored red (meat eater) or green (plant eater). Finally, the third, specific attribute was represented pictorally. For example, Tyrannosaurus (keyword tie) was represented by a group of owls with red ties hunting at night. The red ties indicated tyrannosaurus was a meat eater, that tyrannosaurus came from the late period was represented by owls in a night scene, and that tyrannosaurus hunted in groups was represented pictorially (see Figure 3). Cards 8-1/2 x 11 in. (21-1/4 cm x 27-1/2 cm) in

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Insert Figure 3 about here

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size were also constructed to represent each of the time periods, i.e., a rooster with the sun coming up for the early period.

Direct questioning condition. Two visual-spatial displays, one complete and one blank except for the pictures, 12 1/2 x 14 in. (32 cm x 38 cm) in size were constructed which included cells representing the eight dinosaurs with three associated attributes. A picture of each dinosaur along with the dinosaur name was included in each cell. The first attribute was concerned with the period in which the dinosaurs lived, "early," "middle," or "late." Dinosaurs were represented on the left, middle, or right of the display, respectively, to represent this classification. A second attribute dealt with "green plant eaters" vs. "red meat eaters." Meat-eating dinosaurs were placed on the upper portion of the display, while plant eating dinosaurs were placed on the lower portion of the display. The third attribute was unique to each dinosaur. This attribute was written within each dinosaurs' respective cell. The display and presenter's script were developed according to guidelines established by (Engelmann and Carnine (1982).

Two displays, one complete and one blank except for the pictures, 18 x 11 1/2 in. (36 cm X 20 cm) in size representing the three example dinosaurs and their attributes, were prepared to serve as the example. The visual-spatial display used for instruction of target items is given in Figure 4.

Insert Figure 4 about here

Extinction Lesson (Lesson Three)

Nine reasons why dinosaurs may have become extinct were identified and ordered according to plausibility (e.g., Calbert, 1983). Number one represented the most plausible reason, while number nine represented the least plausible. Number nine served as an example item for both conditions. Picture cards 8-1/2 x 11 in. (21-1/4 cm x 27-1/2 cm) in size were constructed for each condition, and a presenter's script was prepared for each condition.

Mnemonic condition. Nine pegword cards were prepared, 4 1/4 in. X 5 1/2 in. (10.7 cm X 14 cm) in size, which contained a picture of the pegword. The picture cards included: (a) the number and pegword, (b) the reason for extinction, (c) the interactive picture between the reason and pegword (for example, for the first reason, the interactive picture is an illustration of a cold dinosaur carrying frozen buns, as in Figure 5).

Insert Figure 5 about here

Direct questioning condition. Pictures were identical to those in the mnemonic condition with the exception that the interacting pegword representation was not included (see Figure 6).

Insert Figure 6 about here

All Lessons--Both Conditions

One-and-a-half to two-minute introductions were written for each lesson. Introductions dealt with information related to, but not included in, the lesson. Introductions were the same for both conditions for each lesson and provided background and meaningfulness as well as allowing the lesson to more closely simulate a typical classroom lesson or unit.

Procedure

All Lessons

Subjects were assigned to small (N = 2-4) instructional groups based upon scheduling constraints. These 24 groups were assigned at random to either of the two instructional conditions. In two cases, when individual instructional groups dropped to less than 2 subjects for any one instructional day, they were dropped from the entire experiment and replaced with another randomly assigned group.

Instruction was delivered to all students by one of two trained female experimenters who each taught mnemonic and direct questioning conditions as they appeared, at random. All students were told that they would learn information about dinosaurs, that they should try hard, and that they would be given a quiz

following each of three lessons. The quizzes on days one, two, and three covered only material learned that day, while the delayed recall measures given on day four covered material from all previous three lessons. All lesson presentations were recorded.

The amount of total time spent in instruction between groups within lessons was held constant. It should be noted that because keywords were taught in the mnemonic condition, the direct questioning condition actually received more instructional time devoted to information to-be-tested.

Vocabulary Lesson

Both conditions. First, students were read the 2-minute introduction to the lesson to provide background and meaningfulness to the information to follow. They were then told that they would learn the meaning for word parts taken from several dinosaur names.

Mnemonic condition. Students were first taught and tested on two examples. Following the two examples, the students were taught keywords for all target items, followed by presentation of the word parts and meanings. Each card was presented once to the group for 15 seconds while the experimenter said, for example, "The word clue for ornith is oar, and ornith means bird. Remember this picture of a bird with an oar." Subjects were then instructed to describe the picture as a group. Students were told

to think of the word clue for each word part and think of what was in the picture to help them remember the meaning.

Direct questioning condition. The two examples were first taught using "direct instruction" procedures described by Carnine and Silbert (1979) as a "common sensical" approach: "The teaching procedure involves first telling students the definition and having them repeat it" (p. 149). In this case, students were told, for example, "Ornith means bird. What does ornith mean?" Students were directed to respond as a group on a manual signal provided by the experimenter. After the practice test, items were presented in groups of 5-5-4 with review after each group and cumulative review at the end. Students were told to think of the cards and how they practiced to help them remember the meaning for the quiz.

Both conditions. At the end of the instructional period (about 10 minutes), students were given the test face down and told to write their name, birthdate, age, teacher, and grade. This activity served as a 90-second "filler" interval between instruction and testing. Two tests were administered for Lesson One. Test One assessed students' recall of the meanings of the word parts. The experimenter read the name of each word part, while students were given a maximum of 30 seconds to respond to each item. Test Two consisted of dinosaur names constructed from the individual word parts (e.g., thero/poda). The experimenter

told the students that complete dinosaur names would be read which were made from the word parts studied. The students were told to read along and think back to the meaning of the word parts and write the meaning for the dinosaur name. Students again were given a maximum of 30 seconds to respond to each test item.

Attribute Lesson

Both conditions. Following a 1-1/2-minute introduction to the lesson, students were told that they would learn three things about each of several dinosaurs. They would learn: (a) if the specific dinosaur was a "red meat eater" or "green plant eater;" (b) the time of the period in which it lived--either "early," "middle," or "late" representing Triassic, Jurassic, or Cretaceous period of the Mesozoic era; and (c) an attribute that was specific to each dinosaur, i.e., "took care of its young." The experimenter explained that a method for remembering this information would be taught.

Mnemonic Condition. Students were first taught a keyword for each of three example dinosaurs (e.g., Spinosaurus is spine). The examples were tested.

Next, students were taught that if the keyword were colored red in the picture, the dinosaur was a "red meat eater," and if the keyword were green, the dinosaur was a "green plant eater."

Students were next shown cards to teach the periods: (a) a rooster with a sun rising in the picture represented the "early

period," (b) a sunny mid-day scene with perspiration and sunglasses represented the "middle period," and (c) an owl in a night scene represented the "late period." Students were then told that the third attribute would be represented differently in each case specific to the particular dinosaur studied.

They were then shown cards for each of the three examples which contained: (a) dinosaur's name, (b) word clue, (c) attributes, and (d) interactive picture. The experimenter said, for example: "Spinosaurus. The word clue for spinosaurus is spine. Spinosaurus is a 'red meat eater,' because the word clue is colored red, from the 'late' period because there is an owl and night scene, and 'had a sail on its back.' Remember this picture of a night owl working on a red spine with a sail on it. Remember, the red spine means spinosaurus is a 'red meat eater,' the night scene and owl mean spinosaurus is from the 'late period,' and the sail means spinosaurus had a sail on its back." The students were then asked the information and prompted to use the retrieval process. A practice test on the three examples was given.

Students were then taught the keyword for each of the eight target items. The target items were then taught using the above procedure with each interactive picture shown for 30 seconds while being reminded of the retrieval process.

Direct questioning condition. All students were given individual visual-spatial display materials. The presentation format followed the procedure outlined by Engelmann and Carnine (1982). First, the chart for the examples was presented. The script followed the "'Touch A' wait, say what is in the cell. 'Ready? Say it'" format. Students then repeated the response. This was repeated for all facts for all cells of the example display. Second, an unprompted display was presented. This display did not have words written in the cells, but did have the dinosaur pictures. The students were asked to identify what was to go in the cells. Repetition of display strategies occurred as needed.

After a practice test, students were taught the eight target items via similar prompted and unprompted displays. Total time for instruction was held constant with the mnemonic condition. Students were reminded to think back to the visual display and try to remember where information was to remember the attributes for the quiz.

Both conditions. After a 90-second "filler" activity, a test was administered. While the experimenter read the test questions, students were required to write each answer independently within 30 seconds.

Extinction Lesson

Both conditions. Following a 2-minute introduction to the lesson, students were told that they would learn eight reasons why

it was believed that dinosaurs became extinct. The eight reasons would be listed with number one representing the most plausible reason and number eight the least plausible. Students were told they would be taught a method to remember this information.

Mnemonic condition. Students were first taught the pegwords for the numbers one through nine (i.e., one is bun, two is shoe, three is tree, four is door, five is hive, six is sticks, seven is heaven, eight is gate, and nine is vine). A practice test on the pegwords was given.

Next, students were taught the example and the retrieval process, then tested. Students were then taught the list of eight possible reasons for extinction via cards with interactive pictures depicting the pegword and the reason. For example, a picture of a cold dinosaur carrying frozen buns was shown for reason number one (i.e., "the climate became cold"). Each card was shown for 20 seconds. Before the test, students were reminded of the retrieval process.

Direct questioning condition. Students were taught and tested on the example reason, number nine. Target items were then presented in the following format: (Show card.) "Reason number one, dinosaurs died out because the climate became cold. What was the reason number one?" (Students respond.) The card was placed face down and the question repeated. The above format was followed for the eight target items, which were presented in

groups of four. A cumulative review occurred for as long as time would allow, in which corrections and feedback were given.

Both conditions. After a 90-second "filler" activity, a test was administered. Students were given a maximum of 30 seconds to respond to each item.

Delayed Recall Tests

Both conditions. On day four, all students were administered two tests covering combined content from the three lesson tests (vocabulary application was not retested). During the first administration, the tester read the test requiring students to produce (write) the correct answer. The second time, the students were required to identify (match or circle) the correct answers. Students were given a maximum of 20 seconds to respond to each item.

Scoring

On all tests except for the vocabulary application test, one-point credit was given for each correct response which contained the exact response or a close synonym (e.g., "bent" for "crooked"). For the vocabulary subtest, a strict scoring procedure was employed in which a point was awarded only if a clear, independent correct response was given; a loose scoring procedure allowed as correct items for which any part of the correct response was given (e.g., ornith = a bird with an oar).

On the vocabulary application test, three test items were repeated for dinosaur complete names (e.g., theropoda, ornithopoda). Redundant items were divided by the total number of presentations to result in a total score possible of 14, as in the vocabulary test.

Next, two conditional probability scores were calculated for each student's score. For example, if the student had scored four items correct on the vocabulary test (strict scoring) and scored three of those four items correct on the application test, his/her conditional probability score would be .75. Also, a conditional probability score was computed on the probability of correctly applying a vocabulary word part which had not been correctly answered. For example, if a student had gotten four items incorrect on the vocabulary test (strict scoring) and, of these, had correctly answered one on the application test, the resulting score would be .25. In either case, individual scores which included zeros in the denominator were excluded. All tests were scored with 100% agreement by two independent scorers unaware of instructional conditions.

Results

Main Analysis

The main analysis, which refers to the t-tests conducted on the three separate lessons and the two delayed recall tests, examined the overall effect between the two treatment groups.

Since experimental and control students were the same for all lessons and all tests, it was thought that a high level of within subject intercorrelation would be obtained between tests; thus to control for an inflated experiment-wise alpha level, a pair-wise Type I error probability of .008 was established. Since subjects were assigned to instructional condition in groups and treatment was delivered in groups, group means constituted the experimental unit of analysis.

Table 1 provides the results of the pairwise comparisons of the main analysis. When variances were found to differ significantly (< .05), a separate variance estimate with Welch's degrees-of-freedom correction was employed (Kirk, 1981). As can

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Insert Table 1 about here

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be seen from Table 1, mnemonically instructed groups consistently outperformed direct questioning groups with the exception of the vocabulary test, strict scoring, in which the mnemonic advantage approached significance ($p = .009$). Obtained effect sizes, computed on individual scores to avoid the use of reduced variance of group means analysis, are also provided in Table 1 as an indication of the magnitude of each effect.

Supplementary Analyses

The analyses described in this section refer to: (a)

students' ability to apply information learned via mnemonic or direct questioning instruction, (b) possible inhibiting effects over days of mnemonic or direct questioning instruction, and (c) analysis of inter- and intralist intrusions in mnemonic or direct questioning conditions. These analyses will be described separately below.

Application of learned information. The mean conditional probability of correctly applying a correctly answered word part was .64 (SD = .52) for students in the mnemonic group, while the mean probability score of students in the direct questioning condition was .56 (SD = .47). Comparisons of the mean of arcsin transformed conditional probabilities yielded no statistically significant difference, $t(53) = .63$, $p = .530$.

Because a large proportion of students in both conditions failed to apply correctly any incorrectly answered word parts, comparisons of these conditional probabilities were made by means of the non-parametric Mann-Whitney U test (Siegel, 1956). According to this analysis, mnemonic condition students were more likely to correctly apply an incorrectly answered word part, $U = 349.0$, $Z = -2.65$, $p = .008$. The mean rank of the mnemonic condition students was 37.42, while the mean rank of the direct questioning students was 27.26.

Intrusions. Only one student (in the direct questioning condition) scored one interlist intrusion, which precluded further

analysis. Due to reduced variability from "floor effects" in the mnemonic condition group, differences on intralist intrusions were analyzed by means of the Mann-Whitney U test and revealed significant differences on all three tests in favor of direct questioning students with resulting Z scores of 6.49, 3.91, and 5.23, all ps < .001, for Vocabulary, Attribute, and Extinction tests, respectively.

Effects over days. Since number of instructional groups was equivalent across conditions, and exactly four groups received each of the three lessons on each day in each condition, responses could be scored for mean performance on Day 1, 2, and 3 of instruction with relative difficulty of lesson controlled. Mean scores over the three days of instruction are depicted graphically in Figure 7. Inspection of this figure reveals no discernible positive or negative trend for either condition across the three instructional days.

Insert Figure 7 about here

Discussion

The major findings of this investigation were: (a) mnemonic instruction condition students scored statistically higher than direct questioning condition students on all immediate and delayed recall tests, except the vocabulary test under strict scoring; (b)

there was no statistically significant difference between groups on applying learned information on the vocabulary application task, but a higher probability of applying previously incorrectly answered information in favor of the mnemonic condition; (c) there was no observable linear instructional effect over days for either group; and (d) direct questioning condition students produced significantly more intralist intrusions than the mnemonic instruction condition students.

That mnemonic groups outperformed direct questioning groups on daily lessons replicates previous investigations which have compared the relative utility of mnemonic and "direct instruction" techniques for LD students in a variety of instructional circumstances (Mastropieri, Scruggs, & Levin, 1984; Mastropieri, Scruggs, & Levin, 1985; Mastropieri, Scruggs, McLoone, & Levin, in press; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985; Scruggs, Mastropieri, Levin, & Gaffney, in press; Scruggs, Mastropieri, Levin, McLoone, Gaffney, & Prater, in press). That the difference favoring mnemonic instruction on the vocabulary lesson fell somewhat short of the required significance level may be a function of the fact that students were exposed to the materials for a shorter period of time than in previous investigations; the finding of a significant difference under "loose scoring" conditions suggests that at least some components of the task were mastered to a greater extent than under the direct questioning condition.

The mnemonic advantage on the cumulative tests as well as the lack of observable deterioration in performance over days has not been previously reported and suggests that mnemonic instruction remains a viable instructional strategy for LD students when it takes place over several days and involves different adaptations of mnemonic techniques. Analysis of conditional probability scores indicated that mnemonically instructed students were equally able to apply learned information as students taught by direct questioning. Additional analysis suggested that mnemonic condition students were more likely than students in control conditions to improve their scores on a second test of related information. This finding, which has been observed previously (Laufenberg, 1985; Mastropieri, 1983; Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1985), suggests that the testing process differentially facilitates later recall for mnemonic students, even when correction and feedback are not provided. Finally, analysis of intralist intrusions suggests stimulus response corrections are stronger under mnemonic instruction, a finding which has also been observed with mildly mentally retarded students (Scruggs, Mastropieri, & Levin, 1985).

In all, results of the present investigation suggest that mnemonic instruction is a highly versatile and uniquely powerful instructional technique for LD students whose immediate effects have not been seen to weaken over several days of instruction.

Further research efforts could do much to further explore the potential of these strategies.

References

Atkinson, R. C. (1975). Mnemotechnics in second-language learning. American Psychologist, 30, 821-828.

Becker, W. C., Engelmann, S., Carnine, D. W., & Maggs, A. (1982). Direct instruction technology: Making learning happen. In P. Karoly & J. J. Steffen (Eds.), Improving children's competence: Advances in child behavioral analysis and therapy (Vol. 1, pp. 151-204). Lexington, MA: Heath.

Borkowski, J. G., & Buechel, F. P. (1983). Learning and memory strategies in the mentally retarded. In M. Pressley & J. R. Levin (Eds.), Cognitive strategy research: Psychological foundations. New York: Springer-Verlag.

Calbert, E. (1983). Dinosaurs: An illustrated history. NJ: Hammond.

Carnine, D. (1976). Effects of two teacher presentation rates on off-task behavior, answering correctly, and participation. Journal of Applied Behavior Analysis, 9, 199-206.

Carnine, D., & Silbert, J. (1979). Direct instruction reading. Columbus, OH: Merrill.

Engelmann, S., & Carnine, D. (1982). Theory of instruction: Principles and applications. NY: Irvington Publishers.

Engelmann, S., Haddox, P., Hanner, S., & Osborne, J. (1978). Thinking basics: Corrective reading comprehension A. Chicago, IL: Science Research Associates.

Gersten, R. (1985). Direct instruction with special education students: A review of evaluation research. Journal of Special Education, 19, 41-59.

Kirk, R. E. (1981). Experimental design (2nd ed.). Belmont, CA: Brooks/Cole.

Lambert, D. (1982). Dinosaurs. NY: Bonarga Books.

Laufenberg, R. (1985). Effects of a transformational imagery strategy to facilitate digit span recall of mildly handicapped students. Unpublished doctoral dissertation, Utah State University, Logan.

Levin, J. R. (1983). Pictorial strategies for school learning: Practical illustrations. In M. Pressley & J. R. Levin (Eds.), Cognitive strategy research: Educational applications. NY: Springer-Verlag.

Mastropieri, M. A. (1983). Mnemonic strategy instruction with lerning disabled adolescents. Unpublished doctoral dissertation, Arizona State University, Tempe.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (1985). Maximizing what exceptional students can learn: A review of research in mnemonic techniques. Remedial and Special Education, 6, 39-45.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (1985). Mnemonic strategy instruction with learning disabled adolescents. Journal of Learning Disabilities, 18, 92-100.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (in press). Direct instruction vs. mnemonic instruction: Relative benefits for exceptional learners. Journal of Special Education.

Mastropieri, M. A., Scruggs, T. E., Levin, J. R., Gaffney, J., & McLoone, B. (1985). Increasing the vocabulary of learning disabled students using mnemonic instruction. Learning Disability Quarterly, 8, 57-63.

Mastropieri, M. A., Scruggs, T. E., McLoone, B., & Levin, J. R. (in press). Facilitating the acquisition of science classifications in learning-disabled students. Learning Disability Quarterly.

McLoone, B. B. (1985). Memory strategy instruction and training with LD adolescents. Unpublished doctoral dissertation, Arizona State University, Tempe.

Scruggs, T. E., Mastropieri, M. A., & Levin, J. R. (1985). Vocabulary acquision of retarded students under direct and mnemonic instruction. American Journal of Mental Deficiency, 89, 546-551.

Scruggs, T. E., Mastropieri, M. A., Levin, J. R., & Gaffney, J. S. (in press). Facilitating the acquisition of science facts in learning disabled students. American Educational Research Journal.

Scruggs, T. E., Mastropieri, M. A., Levin, J. R., McLoone, B., Gaffney, J. S., & Prater, M. (in press). Increasing content-area learning: A comparison of mnemonic and visual-spatial direct instruction. Learning Disabilities Research.

Scruggs, T. E., Mastropieri, M. A., McLoone, B. B., Levin, J. R., & Morrison, C. (1985). Mnemonic facilitation of learning disabled students' memory for expository prose. Unpublished manuscript, Utah State University, Logan.

Siegel, S. (1956). Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill.

Torgesen, J. K. (1980). Conceptual and educational implications of the use of efficient task strategies by learning disabled children. Journal of Learning Disabilities, 13, 364-371.

Table 1

Main Analysis

Data Source	Mnemonic X (SD)	Direct Questioning X(SD)	t	Degrees of Freedom	p	Effect Size
Vocabulary (Strict Scoring)	4.86 (1.86)	2.96 (1.35)	2.86	22	.009	.55
Vocabulary (Loose Scoring)	5.56 (2.04)	2.96 (1.35)	3.86	22	.001	.82
Vocabulary Application	4.13 (2.19)	1.88 (.88)	3.30	14.44	.005	.81
Attribute Learning	13.28 (3.57)	8.33 (1.93)	4.23	16.93	.001	1.00
Extinction Learning	5.28 (1.17)	2.66 (1.13)	5.57	22	.000	1.34
Delayed Recall Production	16.53 (4.33)	11.18 (3.23)	3.38	21	.003	.87
Delayed Recall Identification	21.42 (5.28)	13.13 (2.74)	4.66	14.73	.000	1.24

Figure Captions

Figure 1. Mnemonic representation of ornith = bird.

Figure 2. Direct questioning representation of ornith = bird.

Figure 3. Mnemonic representation of tyrannosaurus attributes (ties colored red in original).

Figure 4. Visual-spatial display for attribute lesson (reduced).

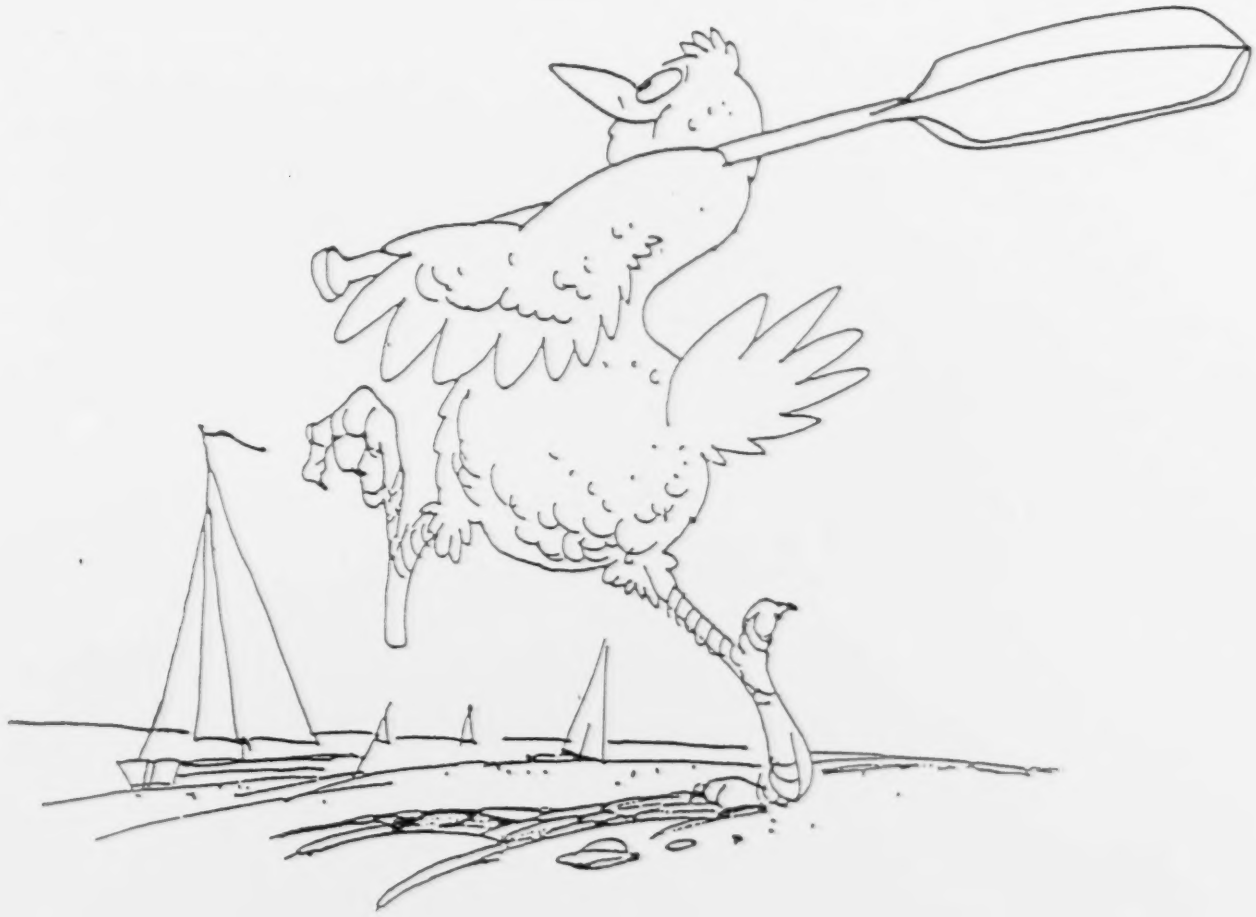
Figure 5. Mnemonic representation for extinction lesson.

Figure 6. Direct question representation for extinction lesson.

Figure 7. Mean scores for three days of instructional days, by condition.

Ornith (oar)

bird



Ornith

bird

Tyrannosaurus (Tie)

period – late
eats – red meat
specific – hunted
in groups

C.
Early Period

D.
Middle Period

E.
Late Period

A.
Dinosaurs that ate Red Meat

B.
Dinosaurs that ate Green Plants

F. Coelophysis

Took care of young

G. Syntarus

Had feathers

H. Allosaurus

Ran as fast as man

I. Tyrannosaurus

Hunted in family groups

J. Melanorosaurus

Weighed 2 Tons

K. Brachiosaurus

Largest animal ever

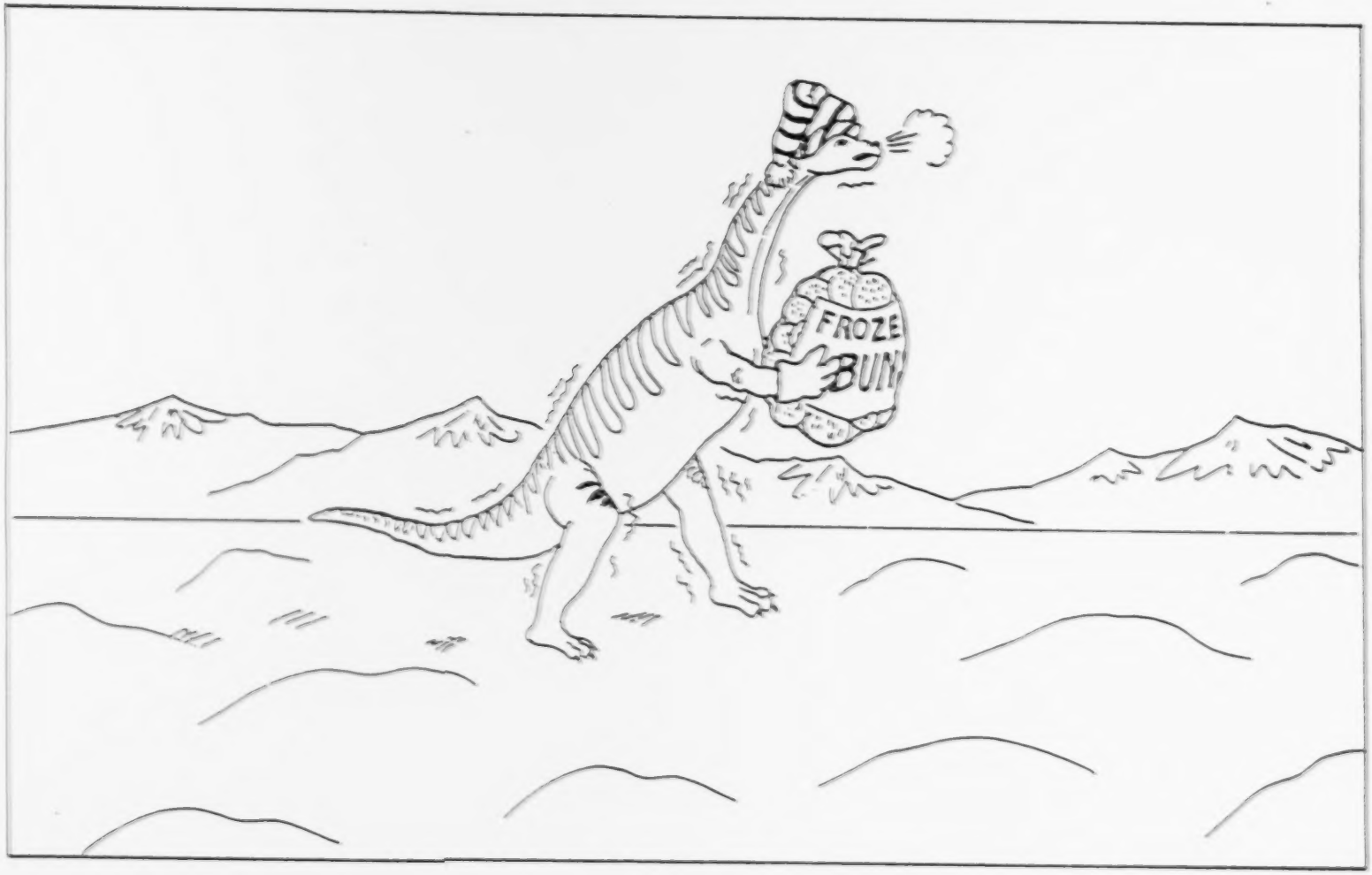
L. Ankylosaurus

Tail like a heavy club

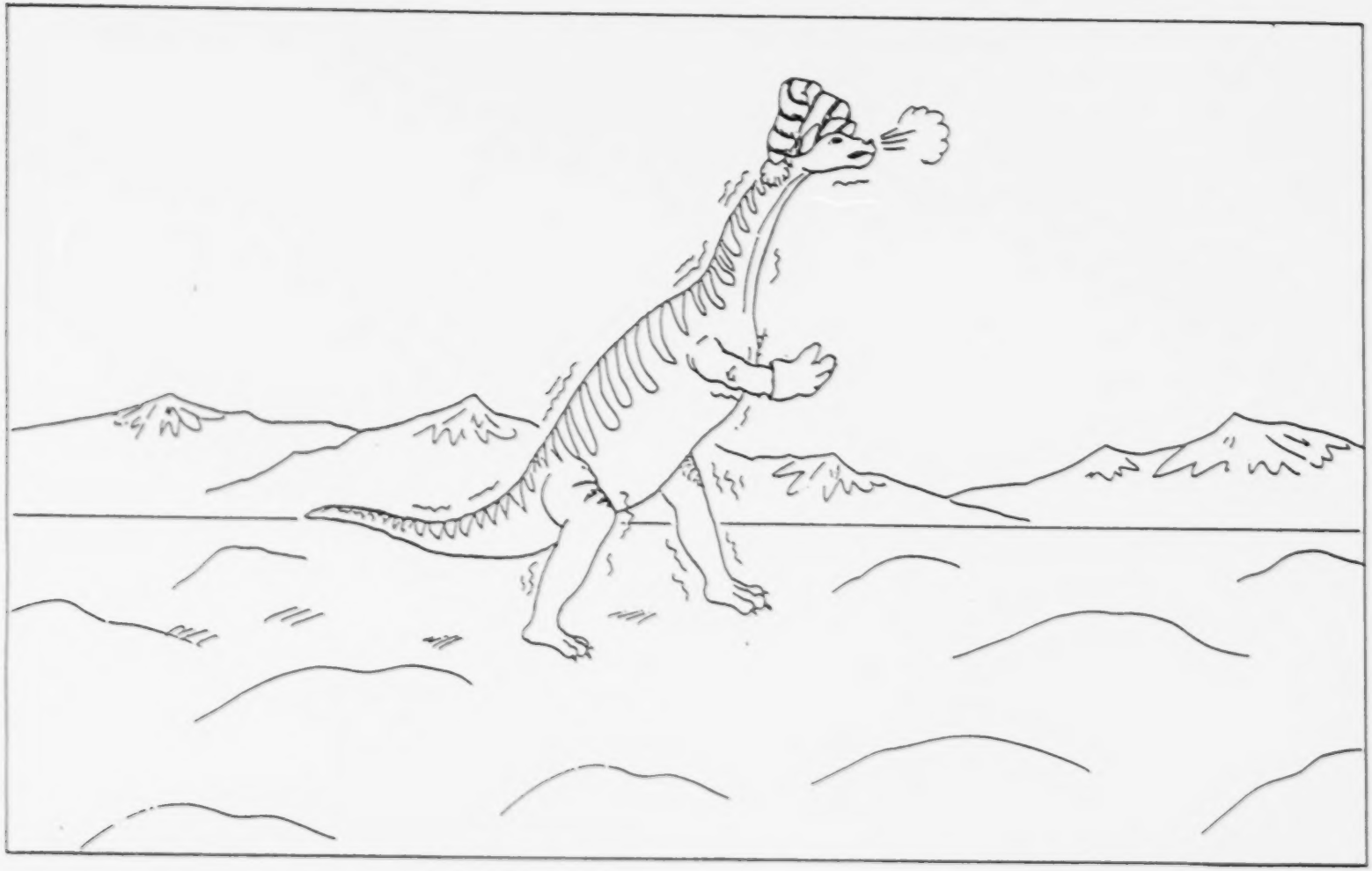
M. Panoplosaurus

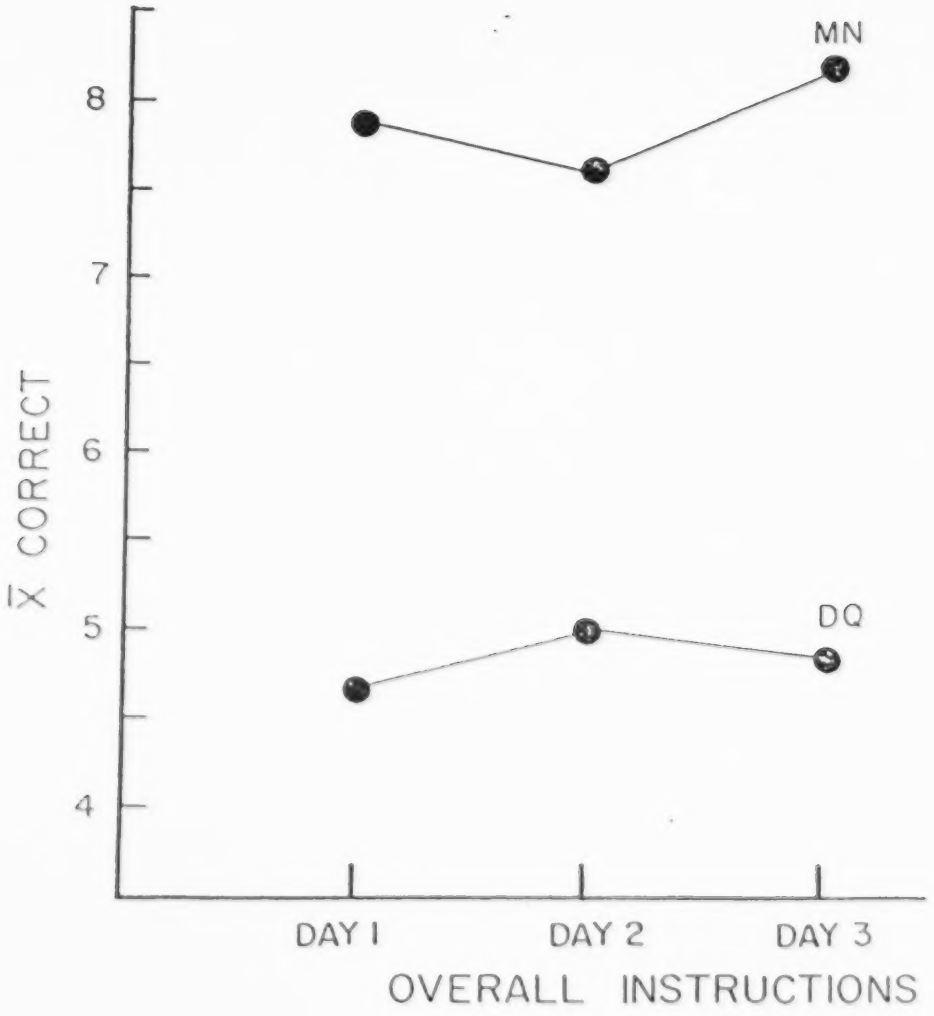
Spikes running length of body

ONE (BUN): DINOSAURS DIED OUT BECAUSE THE CLIMATE BECAME COLD.



ONE: DINOSAURS DIED OUT BECAUSE THE CLIMATE BECAME COLD.




MN
DQ
8
7
6
5
4
X̄ CORRECT
DAY 1
DAY 2
DAY 3
OVERALL INSTRUCTIONS